

Vacuum Measurement

User-optimized Active Gauges
for various applications from
2000 mbar to 10^{-10} mbar



Measurement principles suited for your application

Vacuum Pressure Measurement and Principles

The vacuum pressure range where pressure measurements can be performed ranges from 2000 mbar to 10^{-12} mbar, i.e. over 16 orders of magnitude.

Due to physical characteristics, no single vacuum sensor exists which is capable to perform quantitative measurements within the entire pressure range. For this reason Leybold offers sensors of different designs with own characteristic measurement range, usually spanning several orders of magnitude.

A difference is made between so-called direct and indirect pressure measurements.

Direct, gas type independent pressure measurement

Vacuum sensors:

- **CERAVAC** capacitive gauges equipped with diaphragms with different sensitivity covering the pressure range from 10^{-5} mbar to 1333 mbar (1000 Torr) with high precision.
- **DI/DU** capacitive and piezo pressure sensors with a pressure range from 10^{-1} mbar to 2000 mbar in absolute pressure measurements and -1000 mbar to +1000 mbar in relative pressure measurements.

The direct (absolute) type of pressure measurement is independent of the gas type to be measured. The measurement is performed mechanically by way of the pressure acting upon the surface of a diaphragm.

Indirect, gas type dependent pressure measurement

Vacuum sensors:

- **THERMOVAC** thermal conductivity vacuum gauges after Pirani
- **PENNINGVAC** cold cathode ionization vacuum gauges after the inverted magnetron principle
- **IONIVAC** hot cathode ionization vacuum gauges after Bayard-Alpert for pressures ranging from 10^{-10} mbar to 1000 mbar.

Indirect pressure measurement is determined as a function of a pressure dependent property of the gas (thermal conductivity, ionization probability, for example) and the molar mass, and is therefore dependent on the specific type of gas. The measurement readout is referenced to air or nitrogen and can be applied to other gases via correction factors.

The measurement range is the decisive factor for an appropriate vacuum sensor

Simple gauge and controller selection:

	Measurement Principle	Range [mbar]																Controller					
		2000	1000	100	10	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	GRAPHIX ONE	GRAPHIX TWO	GRAPHIX THREE	DISPLAY ONE	DISPLAY TWO
Direct Gauges	Capacitive / piezo	DI/DU 200 / 2000 / 2001 series																					
		DI/DU 2001 rel.																					
	Capacitive	CERAVAC CTR 100 N series																					
		CERAVAC CTR 101 N series																					
Indirect Gauges	Thermal conductive (Pirani)	THERMOVAC TTR 91N / 96 N series																					
		THERMOVAC TTR 101 N series																					
	Cold cathode ionization (Penning)	PENNINGVAC PTR 225 N / 237 N																					
	Pirani and cold cathode ionization	PENNINGVAC PTR 90 N / 200 N series																					
	Pirani and hot cathode ionization (Bayard-Alpert)	IONIVAC ITR 90 / 200 S																					

The ideal vacuum gauge for your requirements

Application	Sensors:	CERAVAC CTR	Linear pressure sensors DI/DU	THERMOVAC TTR	PENNINGVAC PTR	IONIVAC ITR
Research and Development		■	■	■	■	■
Chemical/Chemistry processes		■	■	■	■	
Heat Treatment/Metallurgy		■	■	■	■	■
Automotive Industry		■	■	■	■	
Space Simulation		■	■	■	■	■
Analytical		■	■	■	■	■
Refrigeration and Air conditioning			■	■		
Chemistry and Research laboratories		■	■	■	■	■
High vacuum pump systems		■		■	■	■
Mechanical Engineering		■	■	■	■	■
Sputter Systems		■	■	■	■	■
Process Industry		■	■	■	■	■
Solar		■	■	■		

For further application examples, please refer to our full line catalog, chapter "vacuum - measuring, controlling".

Leybold transmitters are specially suited for system integration

Our high-precision vacuum sensors meet your demands:

- Highly reliable fore vacuum pressure measurement
- Simple operation
- Highly reproducible measurement results
- Several measurement locations to be constantly monitored
- Simple, cost and space saving installation
- Direct data transfer to PLC/computer via digital/analog interface
- Increased transmission distances (up to 100 m) between measurement location and processing station
- Increased electromagnetic compatibility (EMC) requirements
- Compliance with international standards and regulations (CE, RoHS, WEEE etc.)

Active Sensors / Vacuum Transmitters

Capacitance Diaphragm Gauges (CDG)



Thermal Conductivity Gauges (Pirani)



CERAVAC Transmitters

CTR 100 N / CTR 101 N

The CERAVAC transmitters are suited for corrosive process gases.

Benefits

- New sensing cell: the new all-welded Inconel® sensor is much more robust than ceramic sensors
- Microprocessor-based electronics for excellent accuracy and reproducibility
- Long-term stability: no calibration shifts after bursts of pressure

Principle of measurement

Capacitance vacuum gauge

Measurement/display range

Spanning from 10^{-5} to 1000 Torr, depending on the model

Linear Pressure Sensors

DI/DU 200/201, DI/DU 2000/2001, DI/DU 2001 rel.

These sensors excel through a high overload response as well as excellent corrosion and vibration resistance.

Benefits

- Wide measurement range due to the combined measurement principle
- Very compact: just one sensor needed
- Two-in-one sensor: cost and space saving solution

Principle of measurement

- Capacitive ceramic diaphragm sensor
- Piezo resistive diaphragm sensor

Measurement/display range

Absolute pressure measurement:
0.1 to 200 mbar or 1 to 2000 mbar
Relative pressure measurement:
-1000 mbar to + 1000 mbar

THERMOVAC Transmitters

Operation of the THERMOVAC transmitters is based on the thermal conductivity principle after Pirani. Different versions offer set point relays for improved process control.

The THERMOVAC series is equipped with a LED-ring (360°) showing the sensor status.

Benefits

- New MEMS-Pirani for high resistance
- Fast response and high accuracy: time saving and highly reliable
- Optimized price-to-performance ratio

TTR 91 N(S) / TTR 96 N

Principle of measurement

Thermal conductivity after Pirani

Measurement/display range

$5 \cdot 10^{-5}$ to 1000 mbar

TTR 911 N(C/S) / TTR 916 N

The TTR 911 and TTR 916 have a touch display and/or digital interfaces.

Different versions are equipped with a Parylene HT®-coated sensor for chemical and aggressive applications.

Principle of measurement

Thermal conductivity after Pirani

Measurement/display range

$5 \cdot 10^{-5}$ to 1000 mbar

TTR 101 N(S)

The THERMOVAC TTR 101 N models use a thermal conductivity MEMS Pirani / Piezo solid state sensor combination. They are resilient to vibration and shock venting and provide superior accuracy and gas type independent readings between 10 mbar and 1500 mbar.

Benefits

- Two-in-one sensor: cost and space saving measurement solution
- Large measurement range and time-saving measurements

Principle of measurement

Thermal conductivity after Pirani combined with Piezo

Measurement/display range

$5 \cdot 10^{-5}$ to 2000 mbar for versions with RS 232 / Display / EtherCAT

High endurance - accurate and reproducible results

Cold Cathode Ionization Gauges



PENNINGVAC Transmitters

PTR 90 N

These PENNINGVAC transmitters are the perfect gauge for a wide range of applications.

Benefits

- New MEMS-Pirani / cold cathode combination for cost and time-saving measurements
- Complete coverage of the measurement range from 1×10^{-8} mbar to atmosphere by a single transmitter
- Automatic ignition from the MEMS-Pirani to the cold cathode: ease of use and high process stability
- Modular design for easy servicing

Principle of measurement

Cold cathode ionization after the inverted magnetron principle combined with thermal conductivity (MEMS Pirani)

Measurement/display range

$1 \cdot 10^{-8}$ to 1000 mbar

PTR 225 N / PTR 237 N

Easy system integration, providing excellent process control even in rough applications.

Benefits

- Robust cold cathode sensing cell: reliable measurements and high process quality
- Modular design provides low TCO by easy and inexpensive servicing

Principle of measurement

Cold cathode ionization after the inverted magnetron principle

Measurement/display range

$1 \cdot 10^{-8}$ to $5 \cdot 10^{-3}$ mbar

Multiple function Gauges



Absolute / Differential pressure transmitters

TTR 200 N **PTR 200 N**

The TTR 200 N and PTR 200 N combine different measurement technologies in one housing making them the perfect gauges for load lock applications.

Benefits

- Combination of absolute and differential measurements offers unprecedented loadlock control
- Differential range (relative to ambient pressure): -1013 to 1013 mbar
- The highly accurate differential sensor is ideal for loadlock control since it is insensitive to changes in ambient pressure conditions
- Efficient loadlock control improves throughput and cycle time

Principle of measurement

Up to three sensors in one housing for a wide measurement range

Measurement/display range

TTR 200: $5 \cdot 10^{-5}$ mbar to 1500 mbar
PTR 200: $1 \cdot 10^{-8}$ mbar to 1500 mbar

Gas type independent pressure measurements from 50 mbar to 1300 mbar

Hot Cathode Ionization Gauges



IONIVAC Transmitters

ITR 90/ITR 90 PB **ITR 200 S/ITR 200 SP**

The IONIVAC units permit, by way of combined hot cathode ionization meters with a Pirani sensor, vacuum pressure measurements on non-combustible gases and gas mixtures within a wide range of pressures.

Optionally, the pressure can be displayed on an integrated display.

Benefits

- The Pirani / hot cathode ionization (Bayard-Alpert) combination allows continuous pressure measurements
- Just one gauge required to cover a wide measurement range
- Cost- and space-saving solution
- High process reliability of the ITR 200 through two cathodes

Principle of measurement

Hot cathode ionization vacuum gauges after Bayard-Alpert combined with thermal conductivity after Pirani

Measurement/display range

$5 \cdot 10^{-10}$ to 1000 mbar

High Precision Vacuum Measurements

Technical Data		CERAVAC		Linear pressure sensors		
Vakuu Transmitter		CTR 100 N	CTR 101 N	DI / DU 200 / 201	DI / DU 2000/2001/2001 rel.	TTR 91 N(S) TTR 96 N
Principle of measurement		Capacitance diaphragm Inconel® diaphragm sensor	Capacitance diaphragm Inconel® diaphragm sensor	Capacitive ceramic diaphragm sensor	Piezo resistive ceramic diaphragm	TTR 91 N(S): MEMS-Pirani TTR 96 N: Coated MEMS-Pirani
Measurement range / Display range	mbar	1000 / 1 · 10 ⁻¹ Torr* 100 / 1 · 10 ⁻² Torr 20 / 2 · 10 ⁻³ Torr 10 / 1 · 10 ⁻³ Torr 1 / 1 · 10 ⁻⁴ Torr 0.1 / 1 · 10 ⁻⁵ Torr	1000 / 1 · 10 ⁻¹ Torr* 100 / 1 · 10 ⁻² Torr – 10 / 1 · 10 ⁻³ Torr 1 / 1 · 10 ⁻⁴ Torr 0.1 / 1 · 10 ⁻⁵ Torr	0.1 to 200	1 to 2000 DI/DU 2001 rel.: -1000 to +1000 relative pressure	5 · 10 ⁻⁵ - 1000
Measurement uncertainty	mbar	0.2% of reading ± temperature effect 0.5% of reading ± temperature effect (0.1 Torr)	0.12% of reading ± temperature effect 0.15% of reading ± temperature effect (0.1 Torr)	0.25 % of full scale linearity, reproducibility and hysteresis		5 · 10 ⁻⁴ to 1 · 10 ⁻³ ±10 % of reading 1 · 10 ⁻³ to 100 ±5 % of reading 100 to atm ±25 % of reading
Status indicators		LED		–		LED-ring (360°)
Max. bakeout temperature	°C	Not bakeable		70		85, non-operating
Overpressure limit	bar	3.1		6	5	6
Protection class	IP	40		54		40
Setpoints		0	2	–	–	0 at TTR 91 N 2 at TTR 91 NS 2 at TTR 96 N
Max. cable length Electrical connection	m	30 (type C) Sub-D, 15 pin		25 DI: 7 pole diode plug (5 m) / DU: FCC 68 (5 m)		100 (type A) FCC 68 / RJ45
Interfaces		RS 232		DI: 4 - 20 mA / DU: 2 - 10 V		– –
Controller type		GRAPHIX series		DI: GRAPHIX and DISPLAY series via signal converter DU: DISPLAY and GRAPHIX series		DISPLAY and GRAPHIX series

* 1 Torr = 1.333 mbar

** Example, please refer to catalog for further details

from 2000 mbar to 10^{-10} mbar



THERMOVAC		PENNINGVAC		Loadlock Combinations		IONIVAC	
TTR 911 N(C/S) TTR 916 N	TTR 101 N(S)	PTR 90 N	PTR 225 N PTR 237 N	TTR 200 N	PTR 200 N	ITR 90	ITR 200 S
TTR 911 N: MEMS-Pirani TTR 911 N/C / TTR 916 N: Coated MEMS-Pirani	MEMS-Pirani and Piezo	Cold cathode according to the inverted magnetron MEMS Pirani	Cold cathode according to the inverted magnetron principle	MEMS-Pirani and Diff. Piezo	Cold cathode, MEMS-Pirani and Diff. Piezo	Hot cathode and Pirani	
$5 \cdot 10^{-5}$ - 1000	$5 \cdot 10^{-5}$ - 2000 (RS 232 / Display / EtherCAT)	$1 \cdot 10^{-8}$ - 1000	$1 \cdot 10^{-8}$ - $5 \cdot 10^{-3}$	absolute: $5 \cdot 10^{-5}$ - 1500 ** differential [RS 232]: -1013 to 1013	absolute: $1 \cdot 10^{-5}$ - 1500 ** differential [RS 232]: -1013 to 1013	$5 \cdot 10^{-10}$ - 1000	
$5 \cdot 10^{-4}$ to $1 \cdot 10^{-3}$ ± 10 % of reading $1 \cdot 10^{-3}$ to 100 ± 5 % of reading 100 to atm ± 25 % of reading	$5 \cdot 10^{-4}$ to $1 \cdot 10^{-3}$ ± 10 % of reading ** $1 \cdot 10^{-3}$ to 11 ± 5 % of reading ** 11 to 1333 ± 0.75 % of reading **	$1 \cdot 10^{-4}$ to $1 \cdot 10^{-3}$ ± 10 % of reading** $1 \cdot 10^{-3}$ to 100 ± 5 % of reading** 100 to 1000 ± 25 % of reading** $1 \cdot 10^{-8}$ to $1 \cdot 10^{-3}$ ± 30 % of reading**	± 30 % at $1 \cdot 10^{-8}$ to $1 \cdot 10^{-3}$ mbar	MEMS-Pirani: $1 \cdot 10^{-4}$ to $1 \cdot 10^{-3}$ ± 10 % of reading ** Diff. Piezo: -10 to 10 ± 10 % of reading ± 0.67 mbar **	Cold cathode: $1 \cdot 10^{-8}$ to $1 \cdot 10^{-3}$ ± 30 % of reading ** MEMS-Pirani: $1 \cdot 10^{-4}$ to $1 \cdot 10^{-3}$ ± 10 % of reading ** Diff. Piezo: -10 to 10 ± 10 % of reading ± 0.67 mbar **	15% at $1 \cdot 10^{-8}$ - $1 \cdot 10^{-2}$ mbar > 15% at 10^{-1} - 1000 mbar	
LED-ring (360°)	LED-ring (360°)	LED-ring (360°)		LED-ring (360°)	LED-ring (360°)	-	
85, non-operating	85, non-operating	85, non-operating		85, non-operating	85, non-operating	150 with bake-out extension	80
6	2	2		2	2	2	
40	40	40		40	40	30	
2 [Profibus / EtherCAT / Display] 3 [RS 232]	2 3 [RS 232]	0 3 (RS 232)	0 3 (RS 232) 2 (EtherCAT)	3	3	-	1 - 2
100 (type A) FCC 68 / RJ45	100 (type A) 1 x FCC 68 or 2 x FCC 68 + 1 x Sub-D 15 pin	100 (type A) FCC 68 / RJ 45	100 (type A) FCC 68 / RJ 45 EtherCat: RS 232	20 (type A) Sub-D 15 pin	20 (type A) Sub-D 15 pin	100 (type C) Sub-D, 15-way male	
TTR 911 N Display: - TTR 911 N S: RS 232 TTR 911 N/C: EtherCAT/ Profibus TTR 916 N Display: -	RS 232 / Display / EtherCAT / Profibus	RS 232 EtherCAT	RS 232 EtherCAT	RS 232	RS 232	RS 232 C Profibus	
DISPLAY and GRAPHIX series	DISPLAY and GRAPHIX series	DISPLAY and GRAPHIX series	DISPLAY TWO DISPLAY THREE GRAPHIX series			GRAPHIX series	

Display and Operating Instruments

Ordering Information

Display and Operating Instruments

for active sensors from the series
matching connection lines, 5 m

Model	P/N	CTR	DI DU	ITR	TTR	PTR 90 N	PTR 225/237 N
	DISPLAY ONE	230 001	–	✓ preinstalled	–	✓ 124 26	– 124 26
	DISPLAY TWO	230 024	–	✓ preinstalled	–	✓ 124 26	✓ 124 26
	DISPLAY THREE	230 025	–	✓ preinstalled	–	✓ 124 26	✓ 124 26
	GRAPHIX ONE	230680V01	✓ 124 55	✓ preinstalled	✓ 124 55	✓ 124 26	✓ 124 26
	GRAPHIX TWO	230681V01	✓ 124 55	✓ preinstalled	✓ 124 55	✓ 124 26	✓ 124 26
	GRAPHIX THREE	230682V01	✓ 124 55	✓ preinstalled	✓ 124 55	✓ 124 26	✓ 124 26

Ordering Information (extract from the product range)

Sensor type	Model	Description	Pressure range	Cat. No.
CERAVAC	CTR 100N	DN16 ISO-KF	1 x 10 ⁻¹ Torr - 1000 Torr	230300V02
	CTR 101N	DN16 ISO-KF	1 x 10 ⁻¹ Torr - 1000 Torr	230320V02
Linear pressure sensors	DI 200	DN 16 ISO-ISO-KF, incl. 5 m connection cable	0.1 - 200 mbar	15812V01
	DU 200	DN 16 ISO-ISO-KF, incl. 5 m connection cable	0.1 - 200 mbar	230500V01
THERMOVAC	TTR 91N	DN 16 ISO-KF	5 x 10 ⁻⁵ mbar - 1000 mbar	230035V02
	TTR 91N	DN 16 ISO-KF, 2 switching points	5 x 10 ⁻⁵ mbar - 1000 mbar	230040V02
	TTR 96N C	DN 16 ISO-KF, 2 switching points	5 x 10 ⁻⁵ mbar - 1000 mbar	230045V02
	TTR 911 N	DN 16 ISO-KF, 2 switching points and display	1.2 x 10 ⁻⁴ mbar - 1000 mbar	89654V02
	TTR 916N C	DN 16 ISO-KF, 2 switching points and display	5 x 10 ⁻⁴ mbar - 1500 mbar	89656V02
	TTR 101N	DN 16 ISO-KF	5 x 10 ⁻⁵ mbar - 1500 mbar	230350V02
PENNINGVAC	PTR 90N	DN 25 ISO-KF	1 x 10 ⁻⁸ - 1000	230070V02
	PTR 90N	DN 25 ISO-KF, display	1 x 10 ⁻⁸ - 1000	230085V02
	PTR 225N	DN 25 ISO-KF	1 x 10 ⁻⁸ - 5 x 10 ⁻³	15734V02
Absolute/Differential pressure sensors	THERMOVAC TTR 200N	DN 16 ISO-KF, 3 switching points	5 x 10 ⁻⁵ mbar - 1500 mbar	230365V02
	PENNINGVAC PTR200N	DN 25 ISO-KF, RS232, ATM		230087V02
IONIVAC	ITR 90	DN 25 ISO-KF	5 x 10 ⁻¹⁰ mbar - 1000 mbar	120 90
	ITR 200 S	DN 25 ISO-KF	5 x 10 ⁻¹⁰ mbar - 1000 mbar	230 250

For more detailed information and the entire product range, please refer to the Leybold full line catalog.

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